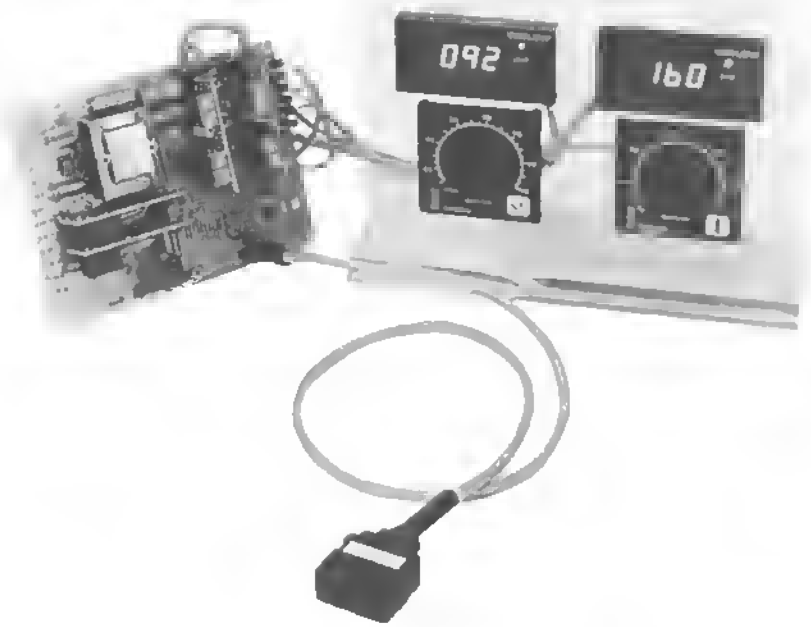
Series 160



Relative Humidity/ Temperature Control System

User's Manual

WATLOW

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W160-MA10-9101
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$5.00
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General Description

The Watlow Series 160 is an integrated relative humidity/temperature control system. The control mode options include factory selected combinations ot ON/OFF, time proportioning, PI using manual reset and full PID. Input for the Series 160 is a relative humidity/temperature sensor. Features include mechanical relay outputs, remote setpot, optional remote digital displays, and various cable lengths to accommodate remote sensor location. The Series 160 is also available as a RH/Temperature signal conditioner only, that can be interfaced to other Watlow controls.

Specifications

Control Mode

Humidity -

- ON/OFF.
  - Hysteresis, fixed: 5% RH.
- Proportional control.
  - Proportional band adjustable: Typically 25%RH ±5%.
  - Cycle time, fixed: Typically 6 seconds ±2 seconds.

Temperature -

- PID: Proportional with auto reset and rate (integral and derivative).
  - Proportional band adjustable: Typically 2 to 25°F/ 1.1 to 14°C.
  - Reset (integral)adjustable: Typically 0.05 to 0.5 repeats per minute.
  - Rate (derivative) adjustable: Typically 0 to 2 minutes per repeat.
  - Cycle time adjustable: Typically 10 to 60 seconds.
- PI using manual reset.
  - Proportional band adjustable: 2 to 25°F/1.1 to 14°C.
  - Manual reset adjustable: ±100% of proportional band.
  - Cycle time adjustable: Typically 10 to 60 seconds.

Signal Conditioner Only

Linear signal output -

- Temperature: 0-5VDC 35 to 170°F/1.7 to 77°C
- Humidity: 0-5VDC 30 to 95% RH

Operator Interface

Setpot Assemblies.

- Temperature setpot with calibrated °F/°C dial scale, remote mounted.
- Humidity setpot with calibrated %RH dial scale, remote mounted.

Display Assemblies.

- Auxiliary humidity and temperature displays, remote mounted.
- LED load indicator lights.

Input

- Humidity (bulk polymer) sensor. 30 to 95% RH.
- Temperature, thin film RTD sensor. 35 to 170°F/1.7 to 77°C.

Output

Humidity -

- Electromechanical relay, Form C, 6A @ 115/230VAC 6A @ 28VDC, 1/8 hp. @ 115VAC,125VA @115VAC.

Temperature -

- Electromechanical relay, Form C, 6A @ 115/230VAC 6A @ 28VDC, 1/8 hp. @ 115VAC,125VA @ 115VAC.

Accuracy

Humidity -

- ±2.5% RH accuracy, factory calibration, standard, non-interchangeable sensor reterenced at 77°F/25°C.
- ±10% RH accuracy, factory calibration, interchangeable sensor reterenced at 77°F/25°C.
- Ambient rejection: <0.17% RH/°F/<0.30% RH/°C rise in ambient.
- Sensor cable lead rejection: No affect over range of allowable lead lengths.

Temperature -

- Control Accuracy: ± 2.7°F/ 1.5°C when the control is at 77°F/25°C, the sensor is within the temperature range.
- Temperature range: 35 to 170°F/1.7 to 77°C.
- Ambient rejection: <0.10 degree per degree rise in ambient.
- Sensor lead resistance rejection: No affect over range ot allowable lead lengths.
- Independent sensor cable lead length.

Terminals

- 1/4" quick connect terminals.

Power

- 120 or 208-240VAC +10%, -15%. User selectable.
- 24VAC +10%, -15%.

Operating Environment

- Control range: 32 to 140°F/0 to 60°C.
- Relative Humidity: 0 to 95%RH, non-condensing.

Exposing any RH sensor to contaminants and/or continuous extreme environments, may cause accuracy degradation. The Watlow sensor, while not totally immune, exhibits superior performance as indicated in tests conducted. Contact the factory for details.

Agency Recognition

- UL197/873 pending.
- CSA 22.2, #24 pending.

Dimensions

Control

• Length:	7.00 in.	178 mm
• Width:	5.25 in.	133 mm
• Height:	1.87 in.	48 mm
• Control Weight:	1.10 lb.	0.50 kg
• Sensor Weight:	0.03 lb.	0.01 kg

Setpot Assembly

• Dial scale:	3 in. sq.	76 mm
• Pot depth behind:	0.67 in.	17 mm
• Knob depth in tront:	0.68 in.	17 mm
• Lead length:	24 in.	610 mm
• Weight:	0.15 lb.	0.068 kg

If you order a model with control option **A** you will receive:
- Signal conditioner, open board assembly.
- Cased sensor module.
- Sensor module cable.

In addition...

If you order a model with control options **B** or **C**, you will receive:
- Humidity setpot assembly.
- Temperature setpot assembly.

Accessories listed below are ordered separately.

Series 160 = Relative Humidity/
Temperature Control.
Model options listed below.

Temperature Scale
A = Fahrenheit, °F
B = Celsius, °C

Line Voltage
1 = 120/208-240VAC
2 = 24VAC

Temperature/Humidity Control Mode
A = Humidity and Temperature signal conditioners only
B = Humidity ON/OFF/Temperature PI with manual reset
C = Humidity Proportional/Temperature PID

Sensor Cable Length
1 to 24 feet available
03 = 3 ft (0.91m) standard length
06 = 6 ft (1.83m)
09 = 9 ft (2.74m)
12 = 12 ft (3.66m)
15 = 15ft (4.57m)
18 = 18ft (5.49m)
21 = 21ft (6.40m)
24 = 24ft (7.32m)

Sensor Calibration
1 = ±10% RH (sensor interchangeable)
2 = ±2.5% RH (sensor **not** interchangeable)

Accessories
- Remote digital display (1 digit resolution)
  D400-1002-0200 Push-to-read set point switch
  D400-0002-0200 Display process only

NOTE:

The Series 160 and required support electronics is purchased as a system. To guarantee system conformance to the specified tolerance, system components must not in any way be interchanged with those of other systems. If you purchase replacements or accessories to your original ±2.5% RH system (160X-XXXX-2000), the system (excluding cables) must be returned to the factory and re-calibrated as a single unit.

Dimensions

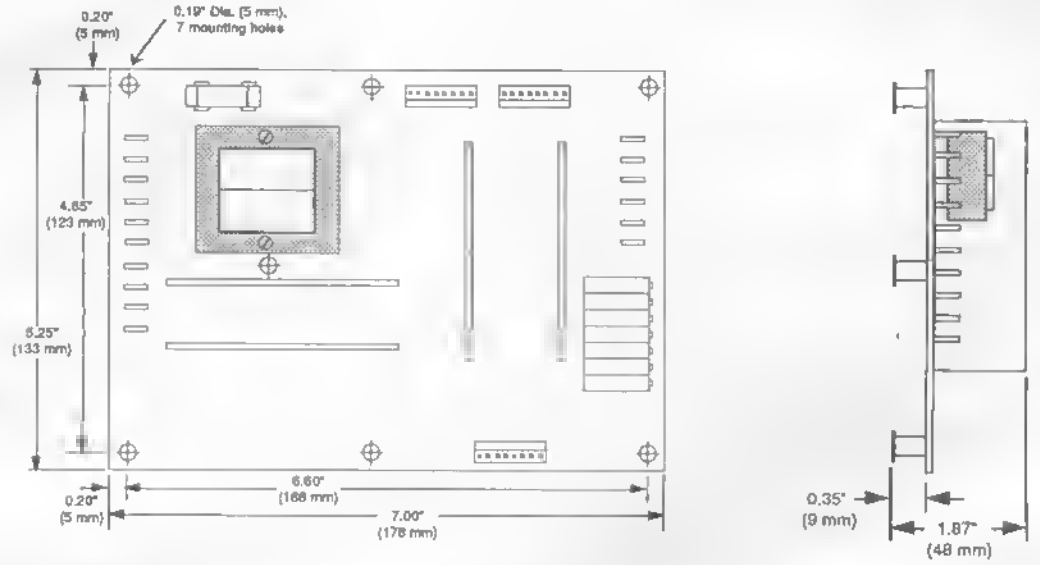
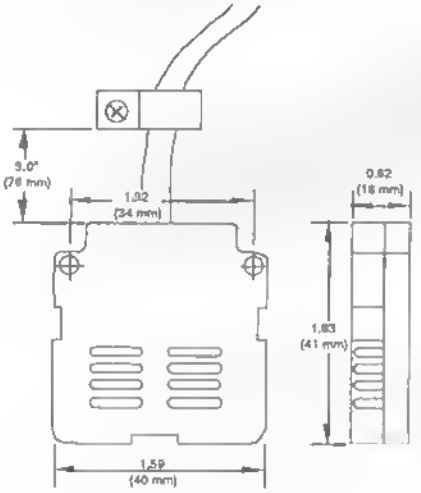


Figure 1 - Series 160 Dimensions



NOTE:

A 3 ft. (0.91 m) standard length cable is shipped with the sensor.

CAUTION:

To prevent unnecessary force of each cable connection on the Series 160, a minimum of 3.0" (76mm) in length is needed as a strain relief, for each end.

Figure 2 - Sensor Module Dimensions

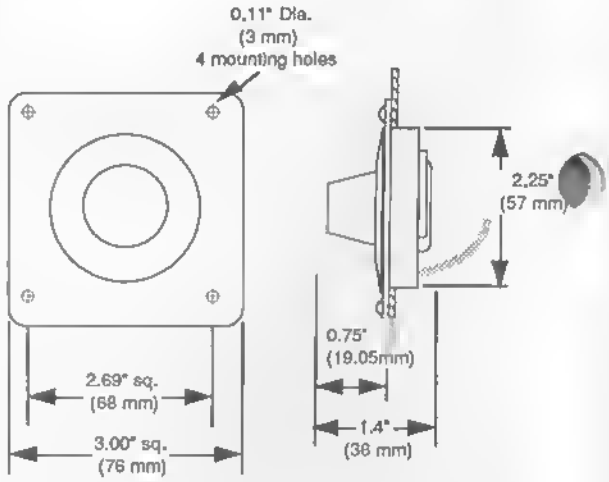
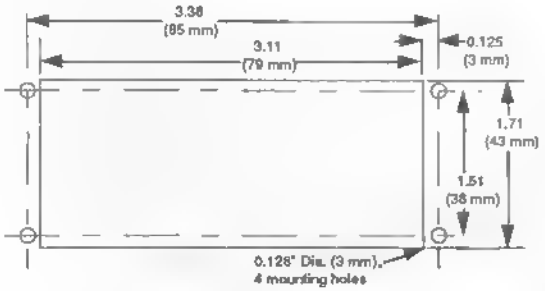
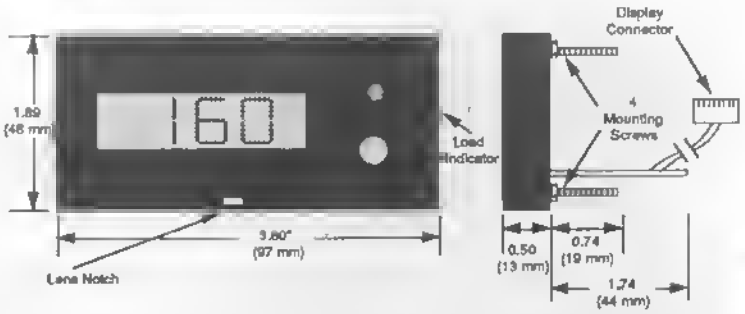


Figure 3 - Setpot Dimensions





2 ft. (0.61 m)
minimum cable length

Figure 4 - Digital Display Dimensions & Panel Cutout

Mounting the Series 160

1. Drill seven 0.19" (5 mm) diameter holes in the desired panel location using the control as a template. See Figure 1.
2. Mount the Series 160 with seven #8-32 screws.
3. Wire the control per Figure 5 or 6 on Page 6.
4. Connect the sensor, load, and line cord. See Page 7 and 8.

Mounting the Sensor Module

1. Drill two 0.15" (4 mm) diameter holes in the desired panel location. **DO NOT USE AS A TEMPLATE.** See Figure 2.
2. Using two #6-32 screws, mount the sensor module keeping the vent holes in line with the air flow. Do not over tighten. The maximum recommended torque is 8.0in./lbs.
3. Connect the sensor module to the 160 with the input connector. See Page 7 for location.

Mounting Remote Setpot Assembly

1. Drill 2.25" (60 mm) diameter hole (or use a 2.25", 2.375", 2.50", or 2.675" punch) at desired remote setpot assembly location. See Figure 3.
2. Using the dial scale as a location template, center and mark all four mounting holes on the dial scale with a center punch.
3. For a dial scale assembly using mounting screws, drill four 0.125" (3 mm) diameter clearance holes. For self tapping screws, tap drill sizes used are:

Tap drill size	for	Screw/thread size
#43 - 0.089 dia.		#4-40
#42 - 0.093 dia.		#4-48

4. Drill four 0.189" (5 mm) diameter holes in desired panel location. See Figure 3.

System Considerations

Before you begin your system design, there are a few important factors to consider:

- **Accuracy and stability requirements.** The specified tolerance of all components in the humidity/temperature system are interactive and inaccuracies of each component can add up.
- **Agency Regulations.** Some regulatory agencies have specific guidelines for sensor location and cleaning. Verify any agency requirements before designing your system.
- **Air flow.** Proper air flow increases evaporation and response time. This is only necessary in applications when rapid system response is critical. Air flow speed cannot damage the sensor.
- **Cleaning.** The sensor **cannot** be cleaned. Locate the sensor where it cannot be easily contaminated. Consider using a filter.
- **Dehumidification.** This is accomplished by using the normally closed (N.C.) contacts on the ON/OFF humidity control, or use the 160 signal conditioner with another Watlow control. Contact the factory for more information on Watlow controls available.
- **Environmental contamination.** Exposing any RH sensor to contaminants and/or continuous extreme environments, may cause accuracy degradation. The Watlow sensor, while not totally immune, exhibits superior performance as indicated in tests conducted. Take precautions to protect your sensor.
- **Response Time.** The response time for both humidity and temperature is almost instantaneous. If a faster response time is needed, add air flow to the application.
- **Humidity generation and temperature.** In a fast responding system, steam can generate moisture. Steam causes the ambient temperature to increase. Consider a cooling system to counteract increased temperature.
- **Sensor retrofit.** All RH sensors degrade with time and environmental conditions. This affects calibration accuracy and will be different for each system, depending on its environment. Prototype your application to determine the life expectancy of your sensor, and start a periodic maintenance schedule.
- **Sensor location.** Locate the sensor so it cannot be physically damaged or exposed to contaminants. A filter can be used to block the flow of contaminants, yet allows air to move freely.
- **Humidity sensitivity to temperature.** A stable temperature is critical to accurate humidity. Example: At 140°F/60°C and 60% humidity, a 9°F/5°C shift in temperature causes a 10% change in humidity.

Line Voltage

WARNING:

To avoid potential electric shock, use National Electric Code safety practices when wiring and connecting this unit to a power source and to electrical sensor modules or peripheral devices.

All wiring and fusing must conform to the National Electric Code and to any locally applicable codes also.

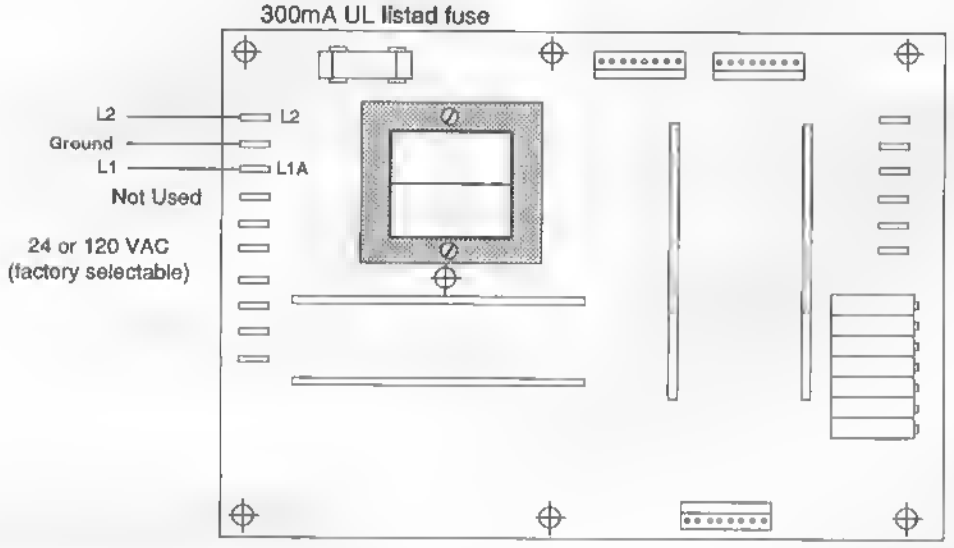


Figure 5 - 24 or 120 VAC Power Wiring . (160X-2X03-X000) or (160X-1X03-X000)

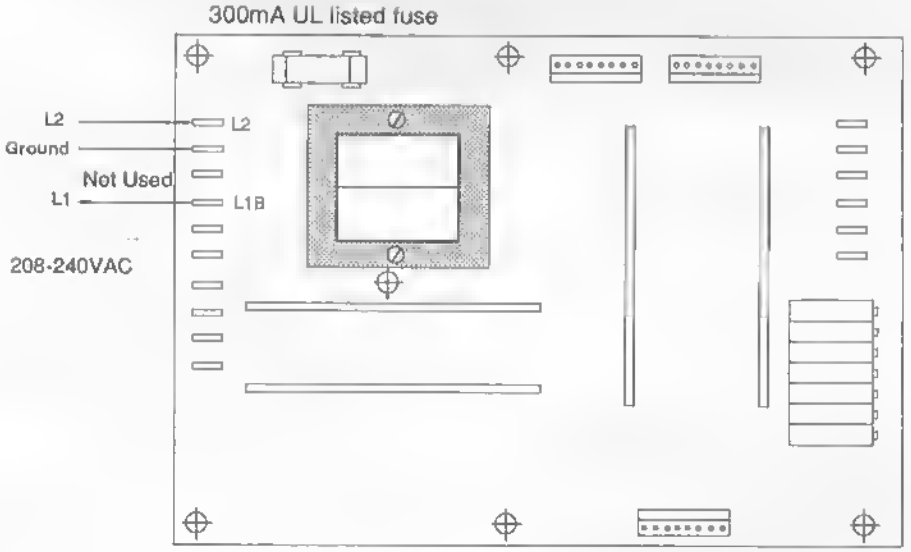


Figure 6 - 208 - 240VAC Power Wiring. (160X-1X03-X000)

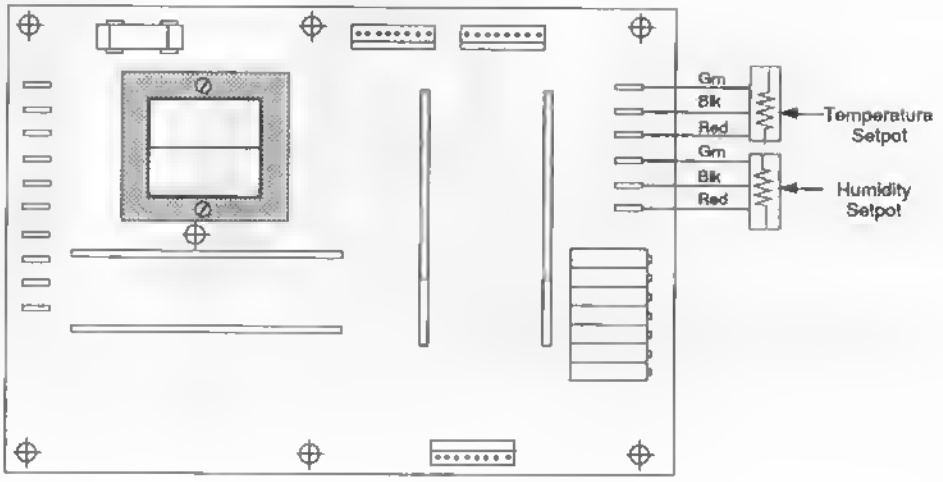


Figure 7 - Remote Setpot Wiring

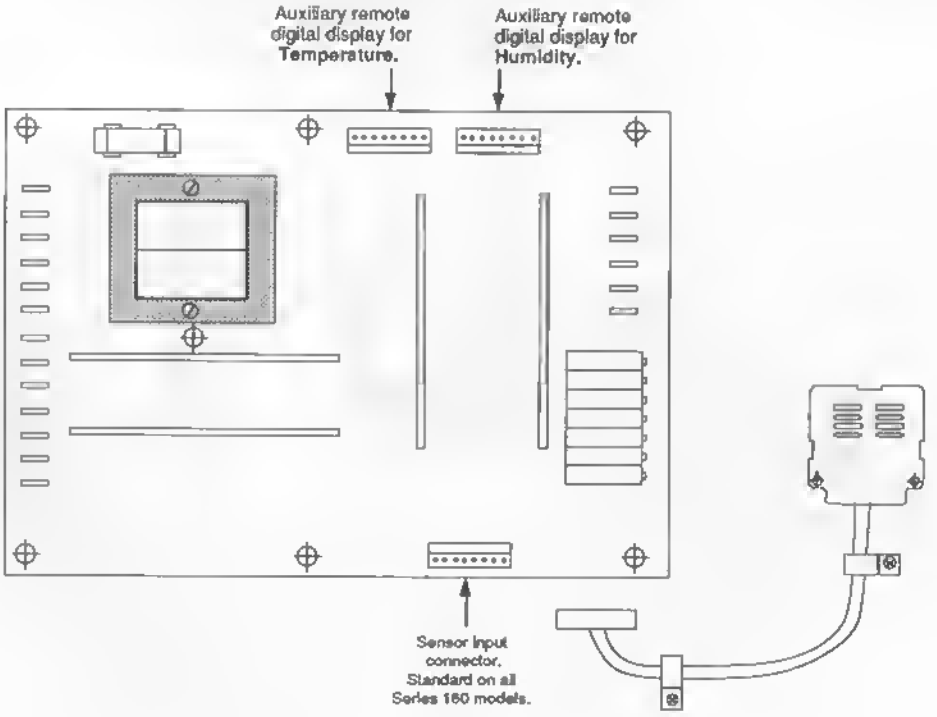


Figure 8 - Input and Remote Display Connections

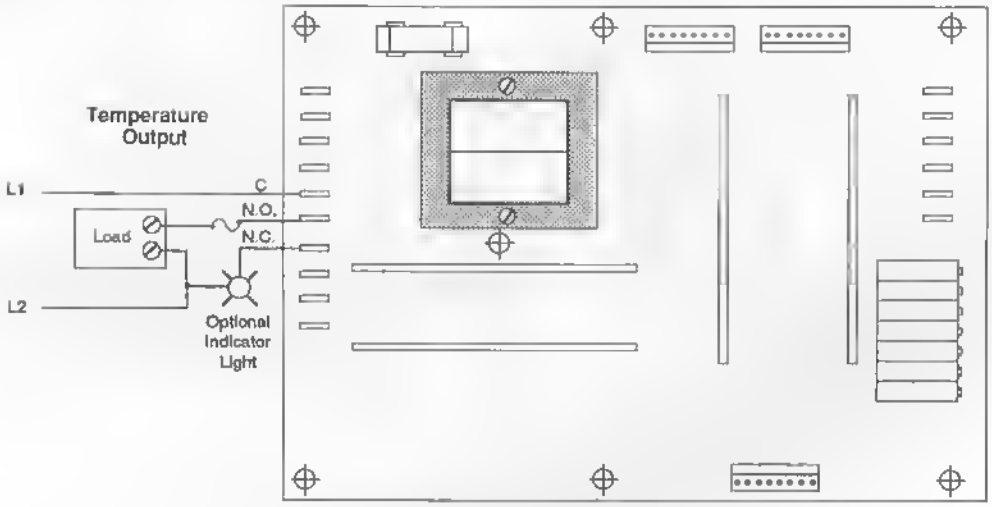


Figure 9 - Temperature Output, 6 Amp Mechanical Relay

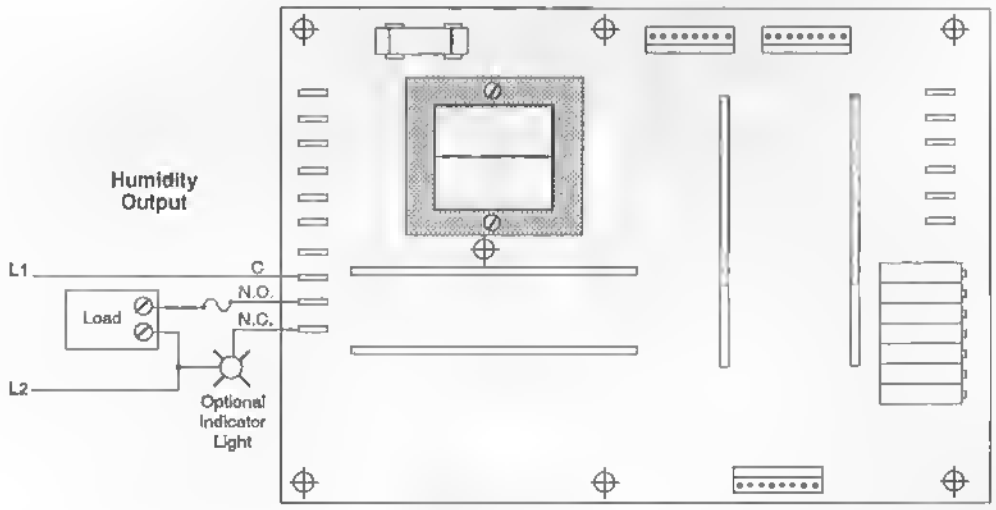


Figure 10 - Humidity Output, 6 Amp Mechanical Relay

♪ NOTE:

Signal conditioner only unit does not have relay outputs available.

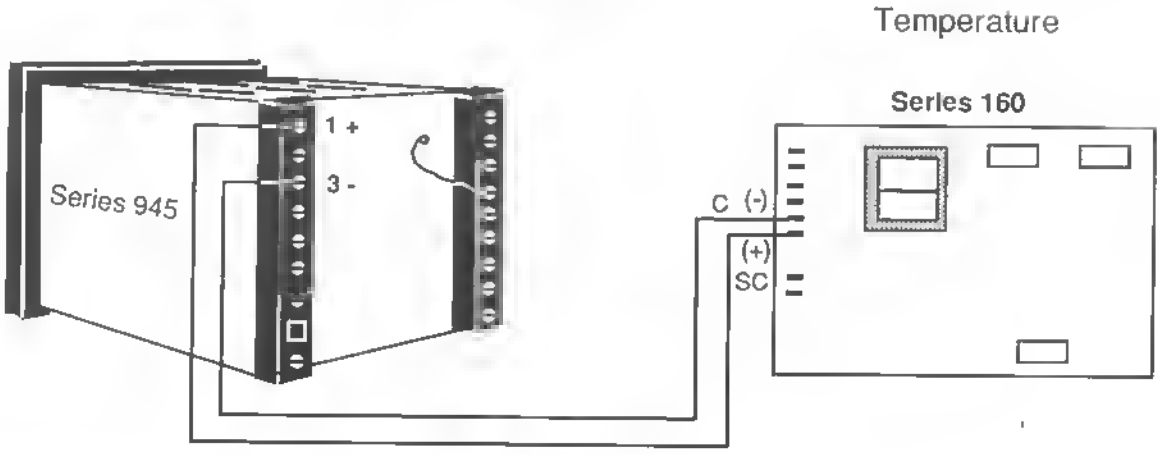


Figure 11 - Temperature Signal Conditioner Output Wiring (0-5VDC, 35 to 170°F/1.7 to 77°C)

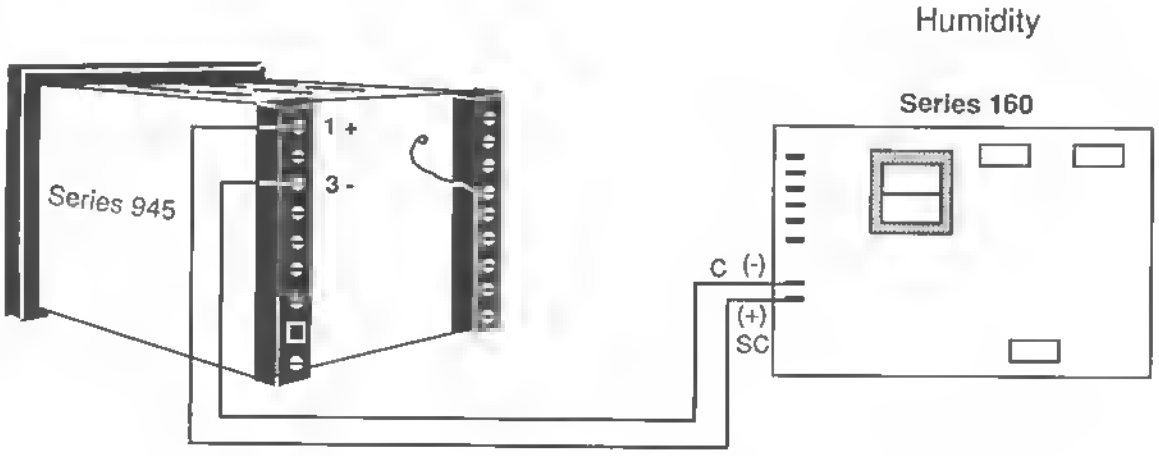


Figure 12 - Humidity Signal Conditioner Output Wiring (0-5VDC, 30 to 95%)

System Wiring Example

WARNING:

Install high or low temperature limit control protection in systems where an over or under humidity/temperature fault condition could present a fire hazard or other hazard. Failure to install temperature limit control protection where a potential hazard exists could result in damage to equipment and property, and injury to personnel.

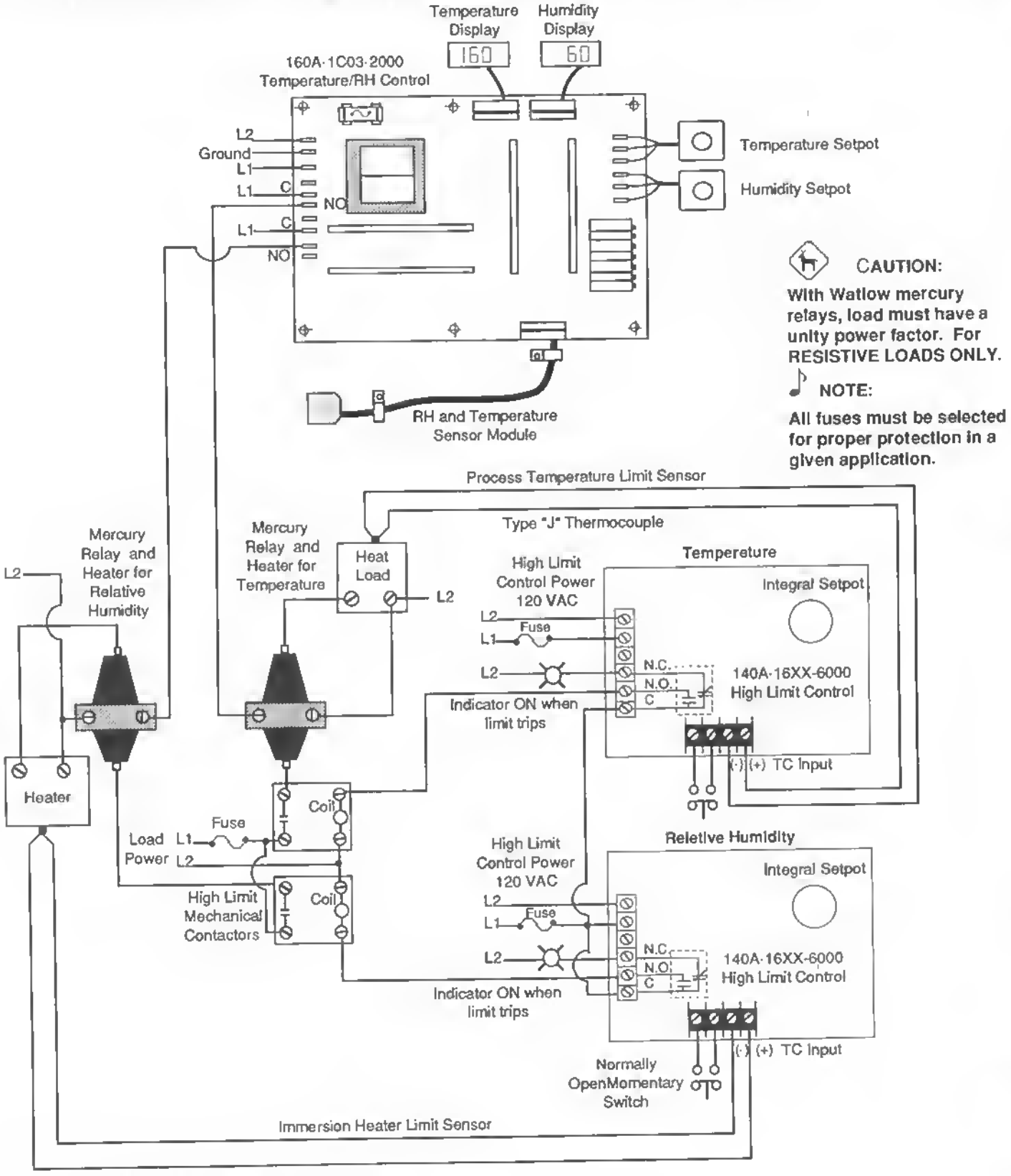


Figure 13 - Series 160 System Wiring Example

♪ **NOTE:**

This is a typical tuning graph. Depending on your PID settings, your system may never respond like this.

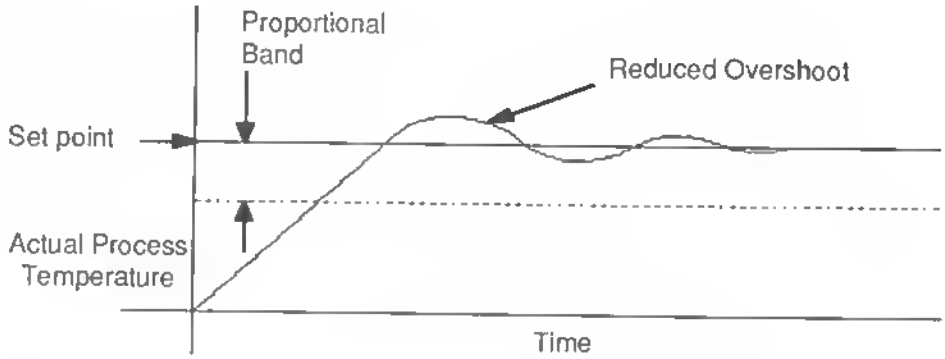


Figure 14 - PID Adjustment Graph for Temperature

Tuning Procedure for Temperature PID Controls

The setup procedure for most applications does not require the full Tuning Procedure for PID Controls, if the following settings provide satisfactory control.

Initial Settings:

1. Cycle time: 10 seconds; set full counter-clockwise (CCW).
2. Proportional band: 12.5°F/6%RH; set to mid-range.
3. Rate: 0; turn fully CCW.
4. Reset: 0.05 repeats/minute; turn fully CCW. This is specific to the Series 160.

Energize the system and allow the actual process temperature to stabilize.

After **any** PID adjustment is made, the actual process temperature may become unstable. Allow sufficient time for it to stabilize before making another adjustment.

Proportional Band Adjustment:
Rotate the proportional band pot CCW 1/4 turn and observe system stability. Repeat until the actual process temperature begins to hunt (becomes unstable). When hunting is observed, rotate the pot CW, in small increments, until the temperature becomes stable. Some systems may be stable enough to allow minimum proportional band (fully CCW).

Rate Adjustment:
The rate pot controls overshoot as actual process temperature approaches set point temperature. Rotate the rate pot 1/4 turn CW. Change the set point temperature 20 to 30°F/°C and observe the approach to set point.

If the actual process temperature overshoots, repeat the procedure until optimum approach to set point is achieved. If the rate pot is advanced too far, the system will be overdamped and approach to set point will be very sluggish.

Reset Adjustment:
Reset adjustment eliminates droop. The reset adjustment controls the time required to drive the error signal to zero. A low setting (0.05 repeats/minute) requires long periods of time for the actual process temperature to reach set point. If the reset time is set too fast (0.5 repeats/minute) the system may become unstable and oscillate about the set point temperature.

To adjust reset time, rotate the reset pot 1/4 turn CW and observe stability. Continue adjusting CW until the system becomes unstable. Rotate CCW very slowly to regain stability.

Cycle Time:
Set as required. Best control is always achieved with faster cycle times. However, if a mechanical contactor or solenoid is used to switch power to the load, slower cycle times may be desirable to minimize the wear on the mechanical components.

NOTE:
This is a typical tuning graph. Depending on your PID settings, your system may never respond like this.

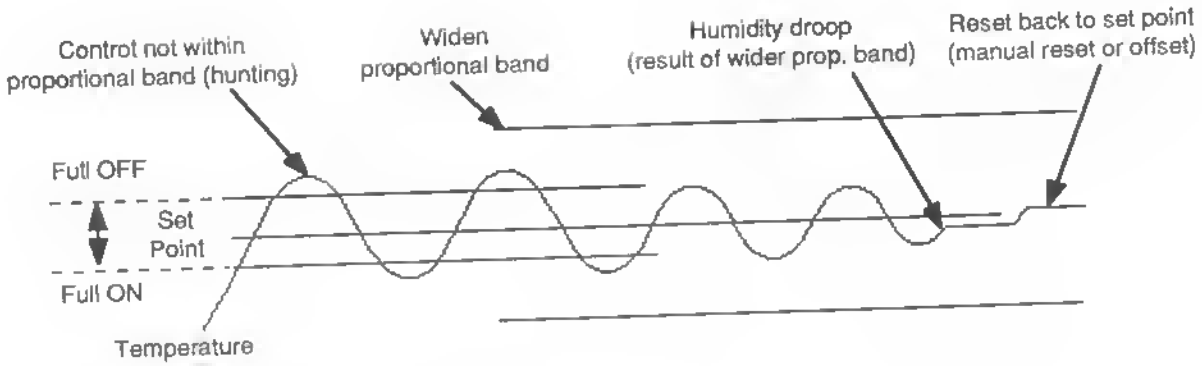


Figure 15 - PI Adjustment Graph For Humidity

Tuning Procedure for Time Proportioning Controls Using Manual Reset (Pi) for Humidity

The setup procedure for most applications does not require the full Tuning Procedure for Time Proportioning Controls using Manual Reset, if the following settings provide satisfactory control.

1. Proportional Band: Mid-range.
2. Cycle Time: Counterclockwise (CCW) if using solid state power switching devices. If using mechanical power switching devices lengthen the cycle time to reduce mechanical wear by adjusting clockwise CW.
3. Reset: Set to mid-range. If actual process humidity is below or above set point refer to manual offset adjustment following.

If the parameter values above do not provide satisfactory control, refer to the full tuning procedure below.

Initial Settings:
1. Proportional Band: Turn fully CW (widest setting).
2. Manual Offset: Turn to mid-range.
3. Cycle Time: Turn fully CCW (fastest time).

Energize the system and allow the actual process humidity to stabilize. When the system is stable, the load will cycle at a constant rate.

Proportional Band Adjustment:
Rotate the proportional band pot CCW a 1/4 turn, observe system stability. Repeat until the actual process humidity begins to hunt (becomes unstable). When hunting is observed, rotate slowly CW, in small increments, until the system becomes stable. Some systems may be stable enough to allow minimum proportional band setting (fully CCW).

Manual Offset:
In virtually all proportional control systems, the actual process humidity may drop or rise to a point that is not the set point humidity. This action takes place even though the actual process humidity has stabilized.

Adjust the offset pot slowly CW if the actual process humidity stabilizes below set point. Adjust CCW it the actual process humidity stabilizes above set point. If large changes in the set point are made, readjustment of the manual reset may be required.

Cycle Time:
Set as required. Best control is always achieved with faster cycle times. However, if a mechanical contactor or solenoid is used to switch power to the load, slower cycle times may be desirable to minimize the wear on the mechanical components.

1. **Actual Process** - The temperature or humidity process controlled in an application.

2. **Anti Reset** - Inhibits reset circuitry from causing set point overshoot.

3. **Bulk Polymer Sensor** - Composite construction allowing water molecules to reach the humidity sensing element, but keeps contaminants from attacking the element. This is an impedance device requiring AC excitation.

4. **Cycle Time** - Time required to complete one cycle to energize and de-energize the output.

5. **Dew Point or Frost Point -** The temperature at which condensation first occurs when a vapor is cooled.

6. **Droop** - The difference between set point and actual process variable.

7. **Duty Cycle** - Energized time divided by cycle time.

8. **Oscillation or Hunting** - Unstable operation occurring if the proportional band is too narrow or the system is upset by some outside source. See Figure 15 on Page 12.

9. **Proportional Band** - When the actual process is within the proportional band, usually specified in units (degrees or %RH), the control output will proportion the amount of power between 0 and 100%.

10. **Rate (Derivative)** - Action that anticipates the rate of actual process temperature rise and automatically widens the proportional band to prevent overshoot. Returns the proportional band to the static adjustment when the set point temperature is stable within the static band boundaries.

11. **Reset (Integral)** - Control action that eliminates offset, or "droop," between set point and actual process. Can be automatic or manual operation.

12. **Relative Humidity (%RH) -** Ratio of water vapor in the air, to the quantity that would saturate the air at the existing temperature. Expressed as a percentage.

13. **Switching Sensitivity or Differential** - The output will de-energize when the actual process increases to set point plus half of the hysteresis. The output will energize when the process decreases to the set point minus half of the hysteresis. This action causes the process to average at set point. This is specific to the Series 160.

14. **System -** A combination of electronic controls, heaters, sensors and switching devices that control a process.

15. **Thin Film RTD Sensor** - Screen printing a resistive element on a substrate.

16. **Wet Bulb/Dry Bulb -** Method determining relative humidity using a look-up table, together with a properly maintained wet sensor (measuring minimum temperature of wetted bulb in air stream) and a dry sensor (measuring actual process temperature).

17.  or  - Musical Notes are used to alert you to important details.

18.  - The Stop Sign alerts you to a "WARNING", a safety hazard which could affect you and the equipment.

19.  - The Deer Crossing Sign alerts you to a "CAUTION", a safety or functional hazard which could affect your equipment or its performance.

Troubleshooting Chart

♪ NOTE:

When returning your unit to the factory for calibration, send only the open board assembly from units with the ±2.5% sensors option.

Problem	Probable Cause	Action
Poor humidity or temperature control.	1. Control parameters are not adjusted properly.	Adjust the proportional band, cycle time, reset & rate per Tuning. See Page 11-12.
	2. The sensor is not detecting the appropriate process.	Locate the sensor so it is measuring the actual process.
	3. Insufficient system air flow.	Circulate air through the chamber.
Inaccurate humidity or temperature calibration and readout.	1. Sensor characteristics have changed.	1. Replace sensor on control with interchangeable sensor option.
		2. Return Series 160 to factory on system with non-interchangeable sensor.
	2. Humidity sensor damaged by environmental contamination.	Replace RH sensor and relocate in air duct with protective filter to minimize potential damage from environmental contamination.
	3. Sensor cable is opened or damaged.	Repair or replace.
	4. A faulty control.	Consult the factory.
Humidity load will not energize or de-energize.	1. Humidity sensor damaged by environmental contamination.	Replace RH sensor and relocate sensor in air duct with protective filter to minimize potential damage from environmental contamination
	2. Open temperature sensor.	Replace RH sensor.
	3. The load circuit is open.	Check the fuses, circuit breakers, load, and wiring. See Wiring on Page 8.
	4. The A.C. input is not connected or is connected improperly.	Check the A.C. input connections. If not present or proper see Page 6.
	5. Humidity setpot damaged.	Replace humidity setpot.
	6. RH sensor cable disconnected.	Reconnect sensor cable or replace.
	7. A faulty control.	Consult the factory.
Inaccurate temperature calibration or readout.	1. Temperature sensor is damaged.	Replace sensor on control with interchangeable sensor.
	2. Sensor cable is opened or damaged.	Repair or replace.
	3. A faulty control.	Consult the factory.

Warranty

The Watlow Series 160 is warranted to be free of defects in material and workmanship for 18 months after delivery to the first purchaser for use, providing that the units have not been misapplied.

Since exposure to contaminants and/or extreme environmental conditions may result in degradation, the sensor is not warranted for performance beyond the time of delivery and installation.

Since Watlow has no control over their use, and sometimes misuse, we cannot guarantee against failure. Watlow's obligations hereunder, at Watlow's option, are limited to replacement, repair, or refund of purchase price, any parts which upon examination prove to be defective within the warranty period specified. This warranty does not apply to damage resulting from transportation, alteration, misuse or abuse.

Returns

The following procedure applies for any products returned to the factory:

1. You must call Watlow Customer Service, 507/454-5300, for a Return Material Authorization (RMA) number before returning any item for repair. We need this information:

   - Ship-to address
   - Bill-to address
   - Contact name
   - Phone number
   - Ship via
   - P.O. number
   - Symptions and/or special instructions
   - Name and phone number of person returning the material.

   We will not accept a return without an RMA number. The RMA number must appear on the outside of the carton and on all paperwork. Cartons without RMA numbers will be returned. Ship on a freight prepaid basis.

2. You need prior approval and an RMA number from the Customer Service Department when you are returning an unused product for credit. Also, we must apply a 20 percent restocking charge for all returned stock controls and accessories.
3. After we receive your return, we will examine it to determine the cause for your action.
4. In cases of manufacturing defect, we will enter a repair order, replacement order, or issue credit for material.
5. If the unit is unrepairable, we will return it to you with a letter of explanation. Repair costs will not exceed 50 percent of the original cost.

Shipping Claims

When you receive your Watlow control, examine the package for any signs of extemal damage it may have sustained enroute. If there is apparent damage either outside the box or to its contents, make a claim with the shipper immediately. Save the originat shipping carton and the packing material.

Technical Assistance

If you encounter a problem with your Watlow Control, review all of your configuration information to verify that your selections are consistent with your application... Input, Output, Displays, Limits, etc. If the problem persists after checking the above, you can get technical assistance by dialing: 1-507-454-5300

An Application Engineer will discuss your problem with you. Please have the following information available when calling:

- Complete model number
- Bar Code Number (located on sensor & mother board)
- All configuration information
- User's Manual

Watlow Controls

Watlow Controls is a division of Watlow Electric Manufacturing Company of St. Louis, Missouri. Watlow is an established manufacturer of industrial electric heating products, in business since 1922. Watlow boasts the ability to begin with a full set of specifications and to complete an industrial product that is manufactured totally in-house, in the U.S.A. Products designed and manufactured by Watlow are electric heating elements, sensors, electronic temperature controls and power switching devices.

The Watlow Controls operation has been designing sotid state electronic control devices since 1962, and has earned the reputation as an excellent supplier to original equipment manufacturers. These OEMs depend upon Watlow Controls to provide compatibly engineered controls which they can incorporate into their products with confidence.

Watlow Controls resides in a 100,000 square foot marketing, engineering and manufacturing facility in Winona, Minnesota.